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SYMPOSIUM 3 – IMPACT DES RETENUES ARTIFICIELLES SUR L'ÉQUILIBRE HYDROLOGIQUE

CONTRÔLE DES CRUES PAR LES RETENUES ARTIFICIELLES

FLOOD MANAGEMENT FOR MATAHINA DAM REPAIR

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ABSTRACT A flood forecasting system using linear systems analysis techniques for flood routing is described. The system was set up to assist in the management of repairs to a hydro dam which was damaged during an earthquake.

INTRODUCTION

In March 1987 an earthquake of magnitude 6.25 on the Richter Scale occurred at Edgecumbe in the Bay of Plenty, New Zealand. (see Fig. 1).
Matahina Dam on the Rangitaiki River near Edgecumbe was damaged during the earthquake. The 2.4 km^2 lake behind the dam was drained at Christmas 1987 when leakage through the dam became apparent. Repair work was begun under the urgency of having the power station recommissioned by August 1988 for winter power generation.
The dam repair work required excavation of both left and right abutments to a depth of more than 30 m below the dam crest. Once the lake level had dropped below the spillway crest the only outlet available was the single, low head, dewatering gate, only 4 metres in height. During the repair upstream and downstream cofferdams were built. Overtopping of the upstream cofferdam would have meant inundating the works, although the downstream cofferdam would have prevented overtopping the dam crest unless the flood reached very high levels.
Figure 1 shows the location of Matahina Dam in the Rangitaiki catchment, together with the location of the flow recording sites used in the project.

HYDROLOGY FOR DESIGN

To establish appropriate levels for the cofferdam historic floods were analysed for such factors as magnitude and frequency, seasonal variation and areal distribution. A report by Riddell (1981) provided useful information on flood analysis including Probable Maximum Flood estimates. To assist in engineering design the probabilities of certain sized hydrological events occurring over two week or 4 month periods were calculated together with the lake levels that the various sized storms would cause. Because of the high risks associated with inundation and overtopping were considered sufficiently great it was decided to install a telemetry based flood forecasting system at the power station. Telemetry was used to retrieve data from three sites upstream of the dam and one downstream site. Lake levels were available via digital readout in the control room.

FLOOD FORECASTING SYSTEM

The flood forecasting system used was that described in Goring (1984). It uses linear systems analysis techniques to account for ungauged tributaries. The application is non-standard because the downstream forecasting station is a lake, not a river site. This causes two problems:
(i) Historical data are in terms of lake levels and lake outflow from which the lake inflow must be calculated.
(ii) Forecasts are in terms of lake inflow from which lake level must be calculated using lake outflow.
Furthermore, the historical data were gathered when the lake was at the normal operating level of RL76; whereas the forecasting is required for lake levels as low as RLA2.

Although the principle involved in calculating lake inflow from lake level and outflow is simple (continuity), its implementation is not easy because small, spurious fluctuations in lake level can cause large swings in lake inflow. For historical data this is usually handled by smoothing the levels, taking cognizance of the levels before and after the time under consideration. However, for calculations in real time, only the levels at the present time and in the past are known, so standard methods could not be used and alternative techniques had to be devised and tested.
The results of a typical routing calculation for the flood of December 1984 are shown in Fig. 2(a). The lower dashed lines are the upstream sites of Whirinaki at Galatea and Waihua at Gorge (other sites in the catchment such as Rangitaiki at Murupara were found to be insignificant during floods).
The upper dashed line is the forecast lake inflow and the solid line is the smoothed, historical lake inflow. Notice the large fluctuations in the recession curve. These are the daily fluctuations in the power generation from Aniwhenua, a power station upstream. In low flows they are significant; in

Fig 1. Rangitaiki River catchment showing flow measuring sites and power stations.

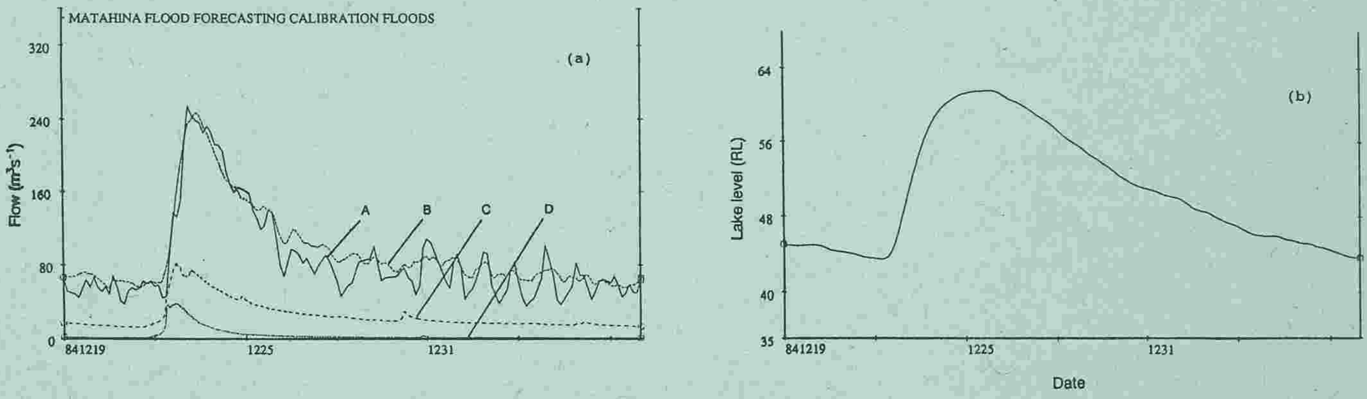

Fig. 2 (a) Lake level and outflow data from a 1984 flood were used to estimate lake inflow (A). The flood forecasting model produced a good simulation of the inflow (B), using data from the Whirinaki at Galatea (C) and Waihua at Gorge (D). (b) Estimated lake level hydrograph during the 1984 flood, assuming an initial lake level of ~ RL45.

floods they are not. The comparison of forecast and actual flows is good. The lake levels which would have resulted had this flood occurred during dam repair are presented in Fig 2(b). Unfortunately there is no means of assessing how accurate this forecast is. Curves such as this were used to assess:

(a) the probability that the excavation would be inundated and/or the crest would be overtopped, and
(b) the likely length of time the excavation would remain inundated.

During dam repair Cyclone Bola hit the east coast of the North Island causing widespread flooding in catchments adjacent to the Rangitaiki. The forecasting system correctly predicted that the Rangitaiki would not flood and construction continued unabated. Subsequent analysis of the rainfall during the cyclone showed that the Rangitaiki was in a "dry slot".

ECONOMICS

The cost of the risk analysis and implementation of the flood forecasting system was offset by savings in design and construction costs. With loss of generation costing $25,000 per day, unnecessary delays in construction were expensive. On the other hand, the cost of damage if protection were not put in place would have been enormous. Thus, the forecasting system allowed engineers and managers to make more informed decisions on the impact of flooding and then take the necessary action, if any.

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SAFETY OF DAMS OF FLOOD DETENTION BASINS – DESIGN FLOOD CRITERIA

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ABSTRACT The linear regulations, which have been carried out in the last few decades at numerous courses of rivers led to an aggravation of the flood risk downstreams. Today flood protection is run as a combination of retention, local measures and passive flood protection. Realization of the measures of flood retention is growing more and more difficult, not least because of the growing demands of environmental compatibility and safety – first of all against an uncontroled overtopping of dams. In addition to that the uncertainty in the estimation of design flood induced the water authorities to set up safety principals for the dimensioning of flood spillways, which seem to be very high compared to other fields. In the determination of design floods for flood spillways the specific marginal conditions of retention basins are rarely taken into account. The contribution deals with the setting up and the evaluation of design floods, in which case the possible various marginal conditions of detention basins are regarded. A regionalization model is used, which is suitable in combination with a multivariate statistical method also for unobserved watersheds for the evaluation of design flood hydrographs of certain probabilities.

INTRODUCTION

In an interdisciplinary workshop recommandations have been worked out in the last few years for the planning, building and management of flood detention basins for the county of Styria/Austria. The following contribution is concerned with the part "design of flood spillway" of the chapter Hydrology. In most cases up to now the design has been made in accordance with large storages for water power plants, without regarding the specific qualities of detention basins. The design flood is defined as the peak runoff (a univariate value), which can be discharged by the spillway outlets under special conditions, without endangering the dam or other important parts of the construction. Mostly it has not been considered, that there exists a spectrum of hydrographs (different combinations of peak and volume) for each probability, from which the decisive event and the resulting peak flow has to be found out, while considering the retention.

CHOICE OF DESIGN PROBABILITY

As there are significant changes in the conditions of regime and climate in the course of several thousand years, there is no hydrological value, of which one can say, that it